SUPPORT GRID

The present invention relates to a grid suitable for load-bearing applications. The invention particularly relates to a grid suitable for supporting articles within an environment which is subject to substantial thermal changes, for example, within a reaction vessel used for exothermic chemical reactions, or within a furnace. The present invention finds particular utility as a support grid for catalyst briquettes, for example in chemical processes involving catalytic oxidation, reduction or other chemical conversion processes.

Support grids having a shape obtained by the notional superimposition of two or more sets of vertically disposed parallel plates or bars arranged mutually at an angle or angles to form a mesh are well-known in the art. In particular, some prior art grids comprise, for example, a web of vertically disposed plates wherein the horizontal cross-section of the web shows a repeating pattern of unit cells of, for example, square, rectangular or triangular shape.

Such grids are normally satisfactory for many load-bearing applications, but are prone to problems in circumstances where the grid is subjected to substantial changes in temperature. In particular, heating of rigid grids of this type can generate powerful internal and external forces due to the thermal expansion of the material (normally metal) from which they are fabricated.

Internal expansive forces within the grid can occur when the heating of the grid is rapid or uneven, and can result in distortion of the grid in a vertical direction to give warping or bowing of the support surface thereof. Such distortions can have an adverse effect on the disposition of, for example, briquettes of catalyst stacked thereon.

Powerful external expansive forces occur due to the overall thermal expansion of the grid material on heating. Such forces can cause damage to the grid itself, or to articles in contact with the grid, for example, vessels or pipes containing the grid or elements supporting the grid. One solution to avoid damage caused by the external expansive forces of the grid is to provide gaps or spaces designed to accommodate such expansive movement of the grid. For example, in the case of circular grid resting on an annular spigot situated in a vertical pipe of corresponding circular cross-section, an annular gap is provided around the grid periphery of the grid to accommodate the thermal expansion of the grid. However, the provision of such gaps or spaces generates additional problems, for example, they can allow undesirable passage of materials (e.g. undesirable bypass of gases) or can become blocked with solid material, e.g. decomposition products such as coke, or materials derived from corrosion of the apparatus, or from the catalyst material or the catalyst support itself. Blocking of these spaces could prevent the intended ability of the grid to expand within the holder.

It is an object of the present invention to provide an improved load-bearing grid. It is a further object of the present invention to provide a grid having improved performance in environments subject to substantial thermal changes.

Accordingly the present invention provides in a first aspect a grid having the form of a web of vertically disposed plates said web of plates comprising (a) a network of strands of plate segments connected by junctions, the said strands terminating only at the periphery of the grid, and optionally (b) one or more internal plate branches, each plate segment being joined at one end to a junction with at least two other plate segments and at the other end either being joined to a junction with at least two other plate segments or terminating at or near the periphery of the grid, said optional internal branch comprising a plate having a free end within the grid and being joined at one end thereof to a segment or to another branch, characterised in that in horizontal cross-section through the grid each segment has at least two angular and/or curved portions which alternate in direction.

The alternation in direction of the angular and/or curved portions may be of equal magnitude or of differing magnitude. Thus, for example, the segment may have a shape similar to the letter "S", or a shape similar to the letter "Z", or combinations of alternating shapes of this type. Thus for example, the segment may comprise an angular

portion having a first angle of, for example, +5° to +170° and a second angle, not necessarily equal to the first angle of, for example, -5° to -170°; or the segment may comprise, for example, a curved portion curving through a first angle of, for example, +5° to +175° and a second angled portion having an angle in the range, for example, of -5° to -170°.

In a preferred second aspect the present invention provides a grid having the form of a web of vertically disposed interconnected plates or strips, said web having in horizontal cross-section a repeating pattern, said pattern comprising one or more series of unit cells, each cell having substantially polygonal shape wherein each polygon contains at least 8 sides, at least two internal angles above 180° and at least four internal angles below 180°, and, optionally, wherein one or more linear or branched internal projections can be provided on one or more sides of a polygon and/or at the junction of two sides of a polygon, with the proviso that the said projections do not bridge any polygon.

The web of the grid in both aspects of the present invention is preferably formed from vertical plates, each of which, by virtue of its height and horizontal width, has high resistance to deformation or bending in a direction parallel to its vertical plane, but, due to its relatively small thickness, is relatively easily deformed or bent in the horizontal plane. Preferably the ratio of the height of the web to the average thickness of the vertical plates forming the web lies in the range 100:1 to 2:1 most preferably in the range 30:1 to 5:1.

In the second aspect of the present invention the defined geometry of the unit cell dictates that the polygon has at least 8 sides, at least two internal angles above 180° and at least four internal angles below 180°. Thus regular polygons having all internal angles equal are clearly excluded. However, some regularity or symmetry to the polygonal shape is preferred. In particular the following characteristics of the polygon are preferred: (a) polygons have an even number of sides; (b) pairs of sides, not necessarily adjacent sides, have equal length; (c) pairs of angles, not necessarily adjacent angles, have equal size; (d) the reflex angles (greater than 180°) are separated from one another by at least two other angles.

The reflex angles are preferably in the range 210° to 330° most preferably 240°

to 300°. The number of reflex angles in each polygon is preferably one for each four or more sides. Thus for a polygon of eight or ten sides, the number of reflex angles is preferably 2, for a polygon of twelve or fourteen sides the number of reflex angles is preferably 3 and for a polygon of 16, 18 or 20 sides the number of reflex angles is preferably 4.

It is preferred that the geometric shape of the polygon can be superimposed on itself when rotated in the horizontal plane through 90°, or through 180° or through 120°.

The polygons can optionally contain defined internal projections. Such projections can be provided primarily to reduce the span of unsupported regions of the grid, and thus to improve the distribution of the load across the grid. The projections, if any, are preferably formed from plates or strip having similar thickness and height to the rest of the web. Such optional projections are positioned within the free space between one or more of the polygons and each such projection projects only from its single point of attachment to the polygon (i.e., no projection may form a bridge across a polygon). The, or each, projection can comprise, for example, a plate or strip having linear, curved, or branched cross-section. The projection may bridge back upon itself if desired, e.g. it can have a branch bearing an element of circular or triangular cross section.

The polygonal cells can be arranged together to form a grid having any suitable overall shape. For example square for a square reactor section or circular for a circular reactor. The diameter of the circle or edge of the square is preferably in the range 50 to 2000 mm and more preferably in the range 100 to 1000 mm.

The pattern of polygons formed by the cross-section through the vertical web of plates or strips is carried through to the upper surface of the grid, and hence forms the load-bearing surface thereof. To increase the surface area of the material forming the support surface, as has been specified above, additional plates or strips are optionally provided which project into the polygonal areas and partially infill these.

In both the first and second aspects of the present invention the grid preferably is free from a solid boundary perimeter plate. Preferably the periphery is provided, in the first aspect of the present invention, by free ends of the defined segments. In the second aspect of the present invention, the periphery is provided by the angular edges of the

polygons or by radially or outwardly directed vertical plates connected thereto.

If desired the grid can be welded in position in a conduit or pipe or can, for example, rest on protrusions on, or in recesses in, such a conduit or pipe,

The material from which the web is formed can be any suitably flexible structural material. Metals are preferred, especially, for example, ductile cast iron, mild steel, stainless steel, or other suitable metal alloy compatible with the process.

The material from which the grid is formed can be coated or surface-treated to provide, for example protective anti-corrosion or anti-coking properties, or to provide a surface having reduced self-catalytic activity. For example, the surface of a metal grid can be alloyed or coated with metal, non-metal or chemical compound. For example the surface can be with aluminised or alonised, or, for example, coated with another metal, e.g. copper, or with a thin layer of a ceramic.

The web can be manufactured by any suitable method, for example, by moulding or casting processes, or by welding, brazing or bolting suitable plates together, or by cutting the web from a block or blocks of suitable material.

The support grid of the present invention finds a wide variety of uses in many areas of industry, particularly in the Chemical Industry in processes involving cyclical heating and cooling.

The support grid of the present invention will be further described with reference to the accompanying drawings wherein Figure 1 is a plan view and Figure 2 is a perspective view of a grid in accordance with the first aspect of the present invention. Figure 3 is a plan view of a grid in accordance with both the first and second aspects of the present invention and Figure 4 is a magnified view of part of Figure 3.

Figure 1 of the drawings represents a horizontal cross-section through the grid depicted in Figure 2 (in perspective view). The cross section is taken at a plane slightly over half the height of the grid. The grid 1 comprises a network of steel strands, for example X-J-W, Y-J-Z and X-J-Z. The grid exhibits considerable rigidity to flexing or bowing in the bending in a vertical direction due to the height of the steel plates which form the strands. However, the steel plates are relatively thin in horizontal cross-section, and hence exhibit flexibility along their length. Each of the said strands terminates only at or near the periphery of the grid represented by the dashed line X,Y,Z,W. The strand X-Y-J comprises two plate segments X-J and J-Z which are

connected at junction J. Segment X-J has one end X at the periphery of the grid, and the other end J at the junction of three other segments W-J, Y-J and Z-J. Each of the segments has branches, for example, segment X-J has single branches 2 having a free end 3 and being joined to segment X-J at 4. Branch 5 has a free end 6, and is joined to branch 7 at 8. Each segment has two angular or curved portions which alternate in direction, for example the segment J-Z bends through about +90° at M and then bends back in the opposite direction through about -130° at N. Cut-away portions 9 at each corner permit the grid to be located on protrusions located on the inside of a square-section conduit.

In use, the grid can, for example, be used for supporting catalyst (not shown) in a conduit (not shown). When heat is applied to the catalyst, or is generated by a catalytic reaction on the catalyst, the grid undergoes thermal expansion. The strands X-J-Z and Y-J-W expand lengthwise, but if the ends X, Y, Z, and W are constrained from movement by the interior wall of the conduit, the expansion is accommodated by virtue of the flexibility of the bends at, for example M and N. It can be seen that an increase in the length of strand X-J-Z will be accommodated by a reduction on the angles, e.g. at M and N. It will be clearly apparent that the force exerted on the conduit wall by the strands of the grid (which are capable of accommodating the expansion by bending at the angled segments) will be substantially less than the force which would have been produced by a network of linear bars of similar cross-section.

Figure 3 shows a plan view of a larger-sized grid formed from a number of units similar to the one depicted in Figures 1 and 2. Figure 4 is a magnified view of part of Figure 3. The grid comprises a network of strands, eg strand P-J1-J2-J3-Q, which comprises of four plate segments P-J1, J1-J2, J2-J3 and J3-Q. Each strand terminates only at the periphery of the grid, e.g. strand P-J1-J2-J3-Q terminates at P and Q. Each strand, comprises plate segments, e.g. segment J1-J2, having at least two angular or curved portions S, T which curves/angles are oppositely disposed. The grid further comprises one or more internal plate branches 10, 11 having free ends 12, 13 and joined at their other ends 14, 15 to a plate segment. It will be seen that the web in Figs 3 and 4 has a repeating pattern comprising a series of unit cells having the shape depicted by the polygon unit J1-J2-J5-J6 drawn in Figure 4 in solid line. The polygon J1-J2-J5-J6 has

twelve sides, two reflex angles of 270° at R1, R2, two reflex angles of 225° at R3, R4, six right-angles at J1, S, J2, J5, R5, J6 and two angles of 135° at A1, A2. Addition of these angles provides a total of 1800°, which is correct for a twelve-sided polygon. During thermal expansion, peripheral constraint of the grid, e.g. by the wall of a pipe in which it may be contained, results in bending of the strands at the angles/bends thereof with the result that the overall expansive force to which the wall or pipe is subjected is reduced compared with a rigid grid formed from linear bars or plates.

Figures 5, 6 and 7 are provided to illustrate examples of other patterns of polygons that can be used to provide grids in accordance with the present invention.

Figure 5, which is in accordance with the second aspect of the present invention, shows diagrammatically in horizontal cross-section a grid 20 having the form of a web of vertically disposed interconnected plates or strips, said web having in horizontal cross-section a repeating pattern, said pattern comprising a series of unit cells, each cell having substantially polygonal shape wherein each polygon contains 8 sides, e.g. sides $n^1, n^2, n^3, n^4, n^5, n^6, n^7, n^8$. The unit cell contains two internal angles above 180° (l^3 and l^4) and at least four internal angles below 180°, i.e. four right angles and two angles (l^1 and l^2) greater than 90° but less than 180°. No branches are shown in this diagrammatic drawing. The unit cell in this case is superimposable on itself when rotated through an angle of 180°.

Figure 6, which is in accordance with the second aspect of the present invention, shows diagrammatically in horizontal cross-section a grid 21 having the form of a web of vertically disposed interconnected plates or strips, said web having in horizontal cross-section a repeating pattern, said pattern comprising a series of unit cells, each cell having substantially polygonal shape wherein each polygon contains 12 sides, e.g. sides $m^1, m^2, m^3, \ldots\ m^{12}$. The unit cell contains three internal angles above 180° (p^1, p^2 and p^3) and nine equal internal angles q^1, q^2, etc., greater than 90° but less than 180°. No branches are shown in this diagrammatic drawing. The unit cell in this case is superimposable on itself when rotated through an angle of 120°.

Figure 7, which is in accordance with both the first and the second aspects of the present invention, shows diagrammatically in horizontal cross-section a grid 22 having the form of a web of vertically disposed interconnected plates or strips, said web having

in horizontal cross-section a repeating pattern, said pattern comprising a series of unit cells, each cell having substantially polygonal shape wherein each polygon contains 20 sides, e.g. sides r^1, r^2, r^3, ... r^{20}. The unit cell contains eight internal angles above 180° (e.g. s^1, s^2, s^3), eight right-angles (e.g. t^1, t^2) and four angles (e.g. u^1, u^2, etc,) between 90° and 180 °. No branches are shown in this diagrammatic drawing. The unit cell in this case is superimposable on itself when rotated through an angle of 90°.